Complex urban area labeling using Very High Resolution optical images

IGN - MATIS lab.
Saint Mandé, France

PhD thesis proposal

We aim to label complex urban areas. Using Very High Resolution (VHR) optical images, we focus on the most salient topographic objects, i.e., roads and buildings. In areas where a large amount of reference data is available, it is possible to compute deep-learning based models so as to recognize such objects. Then, these models will be propagated to areas where only few labeled instances exist. Finally, the classification obtained with our tailored architectures will be refined with a structured reasoning that includes detected geometrical patterns and a priori knowledge on the interaction between main urban elements.

Context

Creating and updating 2D land-cover geodatabases is a slow, tedious and highly expensive process that still requires significant inputs from human operators. Automation remains limited. To top it all, in many areas, even the automatic detection of simple anthropic elements such as roads and buildings remains a complex task.
The spectral resolution (∼4 channels) of most of the Very High Resolution (VHR) airborne and satellite sensors limits the capacity of classifiers to discriminate all the objects of interest in urban environments. This is in particular due to the fact that many elements from different classes have similar spectral content and that many shadow areas exist. Texture feature extraction can be used to cope with such issues. However, it remains local information that does not fit very well with the global human interpretation of urban areas, based on regular patterns and relationships between them.

The very last years have witnessed the wide adoption of deep-learning techniques for various computer vision detection and classification tasks, with often great success with respect to previously existing approaches. In particular, first tries on the semantisation of geospatial imagery have shown that the adoption of classification models tailored for other purposes is valid. It also shows the great potential of such techniques in case of fine design and tuning for the specific task of pixel-wise land-cover prediction. This is also the most adapted technique in case of a huge set of learning instances.
One of the main strengths of deep-learning techniques is the capacity of avoiding the tedious step of designing a suitable feature set to discriminate the classes of interest. They are implicitly generated during the training phase. One of the consequence is that the object context and multiple levels of interpretation can be directly taken into account. First promising works have also shown that models can easily adapt themselves to dynamic conditions.

Deep learning techniques have raised the interest of the remote sensing community but have been barely correctly exploited so far for the dense classification of geospatial images. Such methods should be coupled to the optimal exploitation of high-quality existing land-cover geodatabases that are available over large scales and at different scales (e.g., IGN topographic and Copernicus-based databases).
In additional, a new question arises : how to generalise generated models ? Many urban areas do not include large amount of existing land-cover databases but only few instances instead. Existing

models may not be sufficient and should be locally adapted using weakly labeled and imperfect training data.

In this PhD work, we will mainly focus on the adaptation of a deep-learning based model, generated on an area with a large amount of reference data, to regions where only few instances are labeled. We target to improve the generalisation capability of the model using such weakly labeled datasets. Eventually, we will use a priori knowledge on the areas of interest (objet shapes and the overall urban structures) to improve and provide a structured ouput of the deep-based proposal.

Workflow

The PhD work will be divided into three main tasks :

i) Computation and evaluation of a deep-learning model adapted to VHR land-cover classification in urban areas and based on a large amount of reference data ;

ii) Model adaptation in case of weakly labeled landscapes ;

iii) Structured labeling of the output of the deep-based architecture with the integration of a priori knowledge and local decisions (detected patterns, segments etc.).

Application requirements

— The candidate should belong to one of the country of the European Union or to Switzerland ;

— Strong knowledge in image processing, computer vision, and remote sensing ;

— Good knowledge of programming language (C++/Python) is mandatory ;

— Knowledge of the French language would be an asset.

Supervision

— Clément MALLET - IGN/MATIS lab. (Saint-Mandé, France) – Personal webpage ;

— Devis TUIA - University of Zurich (Switzerland) – Personal webpage.

PhD location

The PhD work will be carried in the MATIS lab. of IGN, which is the French Mapping Agency. Saint-Mandé is located near to Paris with direct access with the subway.
The MATIS laboratory of IGN is specialised in photogrammetric computer vision, image analysis and remote sensing from both geospatial imagery of and ground based imagery (e.g., provided by mobile mapping systems). It is composed of 35 researchers, including 16 permanent researchers.

Contact

Contact Clément MALLET – `clement.mallet@ign.fr` – for more information about any aspect of the position and research topic.

Application

Application should include :

— a CV ;

— a motivation letter, linked to the PhD thesis topic ;

— the recommendation letter of the responsible of the Master thesis (or equivalent) and any other relevant support letter ;

— In a **single PDF file**.

We remind you that the appliant should come from one of the country of the European Union or Switzerland.
Every application that does not fullfil all elements required above will be silently ignored.

Deadline for application : **25 April 2016**.